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Reinventing a Computer Technology Curriculum to Meet the Needs of Students and Future Employers

Abstract

Through the years we have observed that students are often unable to see a broader perspective of why they are studying various topics and required classes. Students seem to be less able to make the connections that they need to make between the different classes and disciplines. This paper discusses a computer technology curriculum and its weaknesses, subsequent changes that were implemented with a program overhaul, and an assessment plan that was devised to determine if those changes were effective towards meeting the learning goals.

The changing expectations of both students and their future employers motivated us to reexamine and overhaul the way we teach computer technology. We revised our student learning outcomes to better reflect industry needs and to make assessment more efficiently used as a tool for curricular decision making.

Central to the overhaul is the student portfolio. Every computer course in the new curriculum utilizes the portfolio for recording and reflecting on the experiential learning that occurred in the class projects. Not only does the portfolio provide data for assessment, but it demonstrates student abilities to potential employers.

Another key component of the new curriculum is the studio. Borrowing from a tradition in art and architectural programs, we included six credit hour studios for third and fourth year students. This allows us to introduce a variety of topics that can be applied to relevant projects and help students to make connections, giving them a broader perspective. First and second year students also take a one credit hour studio to help connect topics from their various required classes.

We are currently in the first year of a four-year longitudinal examination of implementing this new curriculum. This paper summarizes what has been accomplished prior to and during the first year of implementation.

Background

Beginning in the spring semester of 2015 a committee was formed with the intention of taking a fresh look at the on-campus computer related degrees. Members of the committee included the campus computer faculty, a faculty member from business management, an academic advisor, and the library director, who has a background in instructional design and technology.

The degrees offered at the time included associate and bachelor degree options in computer systems technology and an associate degree option in web development technology. These degree options were made up of a roughly equal number of credits from computer courses and non-computer courses. The computer courses were three credit hours each and designed to offer a balance between theory and application. Several of the networking and server administration

courses included a lab section. In addition, each degree had a three credit hour capstone project course in the last semester of the curriculum. Bachelor degree students had a capstone project course at both the end of their sophomore and senior years.

Although all of the degree options required a foundation of courses in programming, networking, web development and database systems, the degrees also offered flexibility for the students. For example, the bachelor degree option had eight computer elective slots in the curriculum. In theory this gave students the ability to follow their interests. It also made it fairly easy for associate degree students in both computer systems technology and web development technology to seamlessly continue on to the bachelor degree option.

By many standards the computer degree options were successful. Students were meeting most of the assessment goals for the program's student learning objectives. Employers were hiring the graduates and providing good feedback on how well the students were prepared. Many of the graduates came back years later to talk about their successful careers and express support for the degrees. However, in the semesters leading up to the spring of 2015, limited faculty resources, decreasing enrollment and technology advances prompted the computer faculty to take a fresh look at the curriculum.

Process

The committee met on a weekly basis through the spring and fall semesters of 2015 with a goal of implementing a revised computer curriculum by the fall 2016 semester. As mentioned in the previous section, the curriculum committee included faculty members from outside of the field of computing. To ensure that all committee members were in agreement, the following process was utilized:

- Restate the mission and vision of the computer degrees to determine who we are and who we will be in the future.
- Identify and clearly describe the problems to be addressed
- Research possible solutions
- Identify the best solution option
- Create a strategy to achieve the vision using our solution
    - Identify key performance indicators, critical success factors, and strategic objectives
    - Ensure that our assessment process reflects the revised curriculum

It is important to note that outside input was gathered to make sure any modifications aligned to industry needs. The committee met with the computer technology degree program's industrial advisory board. The industrial advisory board is made of technology experts from several

companies and organizations in the region. The advisory board provided feedback on proposed solutions and helped redefine program-level student learning outcomes.

Eventually the committee agreed on changes and developed an implementation plan. At this point courses and programs were developed into a proposal and passed on through the university course and curriculum approval process.

Key Artifacts of the Process

This paper will not attempt to present all of the brainstorming ideas, diagrams, and artifacts produced during the process. However, a few key artifacts may help the reader understand the context of the revised curriculum:

Mission Statement

We educate students from Kansas and the Midwest, transforming them into capable, ethical members of the computing profession. We provide Kansas and Midwestern industries with employees that are ready to take responsibility and meet the needs of industry now and in the future.

Vision Statement

The program will be the preferred choice of students in Kansas and the Midwest because of its focus on entrepreneurial and project-based experiences tailored to the specific needs of students and industry. This will allow us to attract superior students, improve the student experience and meet the needs of industry, who in the future will be the employers of our students.

Problem Statement

Students are often unable to see a broader perspective of why they are studying various topics and required classes. Students seem to be less able to make connections they need between different classes and disciplines. Students do not currently have an effective and efficient method to reflect on project results and retain projects for eventual job interviews.

Strategic Objectives

- Create a junior/senior computer curriculum that will be seen as a unique, hands-on experience that is available only at our institution.
- Re-define the freshman/sophomore experience as a time for students to prepare for the rigor of the new program.

- Recognize who our students are, including those doing distance courses, associate degree students transferring from community colleges, and those frustrated with larger campuses or theory-based programs.
- Emphasize the junior year as the start of a new curriculum and help all juniors to feel part of the same cohesive cohort.
- Add distance courses to enable remote students to complete the curriculum

Student Learning Outcomes for the Bachelor Degree Option

Graduates of the Computer Systems Technology option will demonstrate:

- An ability to identify and apply current technical concepts and practices in the core computer systems technologies of database management, web technology, computer programming, digital media, and network/system administration.
- An ability to analyze, design, implement, test, and maintain complex computer systems that meet stakeholder requirements.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize professional, ethical, legal, security and social issues and responsibilities to make informed judgments, while considering the impact of computing solutions.
- An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.
- An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

Revised Curriculum

The curriculum proposal removed the associate degree option in computer system technology and left only the associate degree option for web development technology. As a result, the new bachelor degree curriculum for computer systems technology requires students to focus on web development technologies in the first two years of study. As a result of this change, all students pursuing the bachelor degree in computer systems will also complete the requirements for the web development associate degree. The associate degree will still provide students with a core foundation in programming, networking, web technologies, database systems, and visual design. However, because the courses teach the foundational concepts in the context of web technologies, students will gain a common depth of knowledge that might otherwise be hard to achieve in classes using disparate technologies. Students seeking only the associate degree should be well qualified for many entry level web developer jobs. Students seeking the bachelor degree will have the foundation of web technology, while continuing to build depth and add breadth as they move through the more advanced classes of the computer systems technology option.

The curriculum map below shows the courses of the bachelor degree option in computer systems technology. The first two years of the curriculum represent the required classes for the associate degree in web development with the exceptions that associate degree students are not required to take MATH 150 Trigonometry or the CMST 333 Portfolio Defense, which is discussed in the Student Portfolio section of this paper.

Freshman Fall	Cr
CMST103 Computing Principles	3
CMST135 Web Fundamentals	3
CMST183 Computer Sys Studio I	**1**
CMST100 College Algebra	3
EDCEP111 University Experience	**1**
ENGL100 Expository Writing I	3
Freshman Spring	
CMST185 Computer Sys Studio II	**1**
CMST247 Programming I	3
CMST250 Hardware & Network Fund	3
MATH150 Plane Trigonometry	3
PHILO105 Intro to Critical Thinking	3
Business elective	3
Sophomore Fall	
DIGME137 Fund of Visual Literacy	3
CMST180 Intro to Database Sys	3
CMST283 Computer Sys Studio III	**1**
CMST335 Programming II	3
COMM106 Public Speaking I	3
Humanities/Social Science elective	
Sophomore Spring	
CMST252 System & Software Fund	3
CMST315 Intro to System Admin	3
CMST333 Com Sys Portfolio Defense	**0**
CMST332 Web Development Project	**3**
ENGL302 Technical Writing	3
Science Elective	4

Junior Fall	Cr
CMST383 Prog & Data Struct Studio	**6**
MATH205 General Calc & Linear Alg	3
ENGL200 Expository Writing II	3
Humanities/Social Science elective	3
Junior Spring	
CMST385 Systm & Database Studio	**6**
STAT325 Intro to Statistics	3
Business elective	3
Unrestricted elective	3
Senior Fall	
CMST460 Software Engineering	3
CMST483 Emerging Tech Studio	**6**
PHILO390 Business Ethics	3
Unrestricted elective	3
Senior Spring	
CMST485 Senior Capstone Project	**6**
Hum/SS/Bus elective (300+)	3
Science elective	4

The bolded courses will be discussed in more detail in the following sections.

Studio Courses

The most striking change to the course list from the previous curriculum is the inclusion of studio courses, which are common in design-oriented fields such as art and architecture.[1,2] Studios are also now being used in science, technology, and engineering areas as well.[3,4,5] These studio courses serve several purposes. The one-credit computer system studio courses in the freshman and sophomore years provide the following benefits:

- Faculty can help students connect the dots between the various classes students are taking that semester and help them see how what they are learning fits into a broader perspective. The hope is that these connections between courses and their relation to the students' career fields will result in a transformative learning experience.[6]
- Computer students will form a cohort early in their academic career. Many studies have shown that students that belong to a community of learners tend to be more engaged and are more likely to be successful in the program. [7,8]
- Along the lines of building a cohort, the studio classes provide a forum for faculty to introduce team building and project management skills doing projects related to their other classes. One of the struggles students had in the previous capstone courses was the ability to handle large team-based projects despite having the technical knowledge to solve the problem. The hope is that by introducing these skills early students will be more comfortable in the capstone courses.
- Finally, the studio classes provide a mechanism to require students to work on keeping their portfolio up-to-date. The portfolio requirement will be discussed later in the paper.

The six-credit studio courses in the junior and senior years provide similar benefits as the one-credit studios with the additional advantages:

- The large block of time dedicated to the six-credit studios will allow faculty members to introduce a variety of topics organized as modules. Certain modules will be required in each six-credit studio, while students will be able to choose from other modules to complete the requirements for the class. The flexibility to choose modules within the studio will allow students to pursue topics they are interested in, but at the same time keep them in touch with their cohort.
- An advantage of keeping students together in a studio is that project teams can be made up of members studying different modules. This provides greater technology diversity for solving problems. In addition, all of the students will gain a better perspective of how different technologies intersect and experience the creative advantages of using a team-based approach.[9]
- Most of the studio courses will be co-taught with two to four faculty members. One benefit to both faculty members and students in this approach is having the opportunity to practice and model a cooperative work environment in the classroom.

The studio classes present challenges for the faculty and the administration of class loads. Another aspect that must be considered is the scheduling of studios, especially the six-credit studios, as they will require some extra logistical work. On the academic side, the tracking of modules and assigning of grades within the studios will need to be addressed.

Capstone Courses

One key feature of the revised curriculum that was a holdover from the previous curriculum are the capstone project courses in both the sophomore spring semester and the senior spring semester. These provide students the opportunity to bring together what they have learned up to that point by completing a significant semester long project. Students work on real world types of projects with real clients. The courses also provide the faculty with an effective way of gathering assessment data to measure student learning in the program.[8] The advantages of having capstone courses in the curriculum have been covered by other papers, so those won't be elaborated on here.

Student Portfolio

Central to the overhaul is the student portfolio. Every computer course in the new curriculum utilizes the portfolio for recording and reflecting on the experiential learning that occurred in the class projects. Students are introduced to the concepts of the portfolio and create a template for their electronic portfolio during the EDCEP 111 University Experience course required by all first year college students.

The portfolio is a major point of emphasis in the studio and capstone project classes. From a pedagogical point of view, the mere act of reflecting on learning has been shown to help students to solidify concepts.[6] Beyond that, the portfolio provides data for assessment of the programs student learning outcomes. Another benefit is that it demonstrates student abilities to potential employers.[11]

Students are required to present and defend their portfolio before being able to enroll in the junior-level CMST 383 studio course. This prerequisite is enforced by having students enroll in the zero-credit CMST 333 Portfolio Defense course. This will provide the opportunity for faculty to assess the readiness of students to be successful in the upper-level studio and project courses.

Competitive Advantages

To summarize the benefits of the curriculum in the context of the college and community where it lives, the following points can be made:

- Small class size, personalized attention from faculty
- Hands-on learning activities
- Project-based learning
- Focus on current and relevant technologies. In the first two year students learn by applying the latest internet technologies and web standards.
- Integrated learning through project-based studio classes
    - Studio classes each semester integrate topics from several classes
    - Students begin building a portfolio in their first semester. The portfolio documents student projects and other activities as they work through the

curriculum. Eventually students can use their portfolio as a way to demonstrate their skills to potential employers.

Observations and Future Plans

At the time this paper is being written, the revised curriculum is in its first year of existence and will be phased in over the next three years. Much of the design work involving the studio classes and their assessment is in process of being finalized. However, one benefit related to assessment and the studio classes has already become apparent. Student weaknesses discovered during the fall semester assessment process were able to be addressed during the spring semester studio course. This helps ensure that this cohort of students don't miss out on important concepts that they will need in later courses. In the previous curriculum, adjustment to fall courses would have been made for future students, but without the studio courses it was more difficult to address weaknesses for the students that had already completed that semester.

We expect that many challenges, both known and unknown, will need to be worked through. We plan to collect data and document the implementation to produce a four-year longitudinal study of this new curriculum. Our hope is that others contemplating similar curriculum revisions can benefit from what is presented here in this paper and may have suggestions for implementation of this curriculum.

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